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Table of Contents

OUR COVER: California ranks first in the Nation as a turkey producing state. Over 19 percent of the Nation's total turkey crop is produced in California. To safeguard the health of this valuable industry, the California Department of Agriculture maintains six poultry disease diagnostic laboratories throughout the State. See page 1. Photo courtesy of *Sacramento Bee*, Country Life section.

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New Turlock Poultry Pathology Laboratory

W. W. WORCESTER, D.V.M., Supervisor of Laboratories, Bureau of Livestock Disease Control

California ranks first in the Nation in turkey production, producing over 19 percent of the Nation's total turkey crop. In addition, she ranks second in farm chickens and egg production and ninth in broiler production. These facts, coupled with the knowledge that early diagnosis of poultry disease is vitally important to the economy of this important California industry, have resulted in the development of poultry disease diagnostic facilities at six locations throughout the State.

To serve the industry effectively and protect the health of California's poultry, the maintenance of adequate disease diagnostic facilities is very essential, and is the main purpose of the diagnostic laboratories of the California Department of Agriculture.

The history of a poultry pathology laboratory in Turlock, California, began in 1947 when Hugh P. Donnelly, State Senator from Stanislaus County, along with members of the poultry industry, proposed a temporary laboratory to serve the central San Joaquin Valley. The original plan was to operate the laboratory only until new facilities, under construction in Fresno, California, were completed. Because the plan was temporary, the facilities were housed in a renovated army barracks building located on the fairgrounds in Turlock. The expected use period for this building was no longer than five years.

Once operations became established, it was apparent that the demand for services in the Turlock area was far greater than anticipated, and it was felt necessary to continue the temporary facility after the completion of the Fresno laboratory.

The volume of work conducted in the Turlock laboratory continued at a high level even after the expected five-year use period of the army barracks building, and it was obvious that new facilities would be necessary if the service were to continue.

Following is a list of the cases submitted to the temporary laboratory as well as the specimens for each individual year:

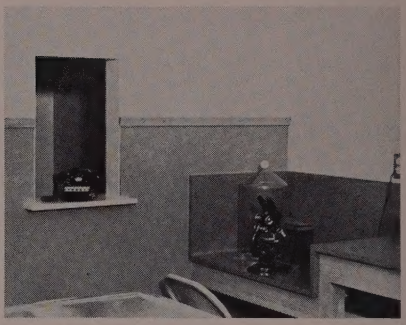
Year	*Accessions*	*Chickens*	*Turkeys*
1948	1,720	1,374	509
1949	3,456	5,626	2,522
1950	3,890	5,785	3,471
1951	4,011	6,426	3,873
1952	4,071	5,517	4,509
1953	3,714	6,387	2,841
1954	4,075	8,412	2,556
1955	4,241	9,095	2,431
1956	5,028	9,302	3,437
1957	4,511	8,452	4,167
1958	4,713	9,024	3,960
Total	43,430	75,400	34,276

From knowledge gained by 11 years experience in the temporary quarters plus experience in building other laboratories, plans were drawn for a new and permanent building. Credit is given to S. L. Jamison, D. V. M. for basic drawings of the new laboratory. The final plans and blueprints were drawn by the Division of Architecture, California Department of Public Works.

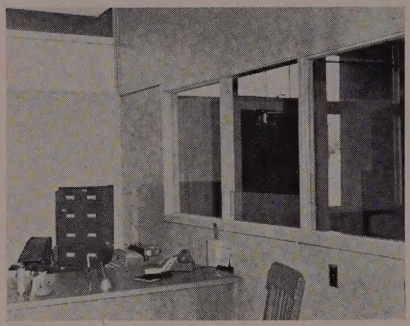
Construction commenced on April and the new facilities were first used on October 7, 1958. Official dedication ceremonies were held on November 14, 1958.

The new Turlock laboratory is constructed on a cement floor with cement blocks comprising most of the framework. It has an overall floor space of 2,800 square feet. It cost approximately $100,000 excluding most of the equipment.

The interior is plaster with acoustic tile on the ceilings in most of the rooms. For serviceability, rooms that receive extensive wear have been wainscoated to a height of four feet with a plastic material. All tables used for necropsy, dishwashing and media preparation are covered with stainless steel. All sinks are stainless steel. Sinks where frequent washing is required, such as the necropsy tables, are equipped with hot and cold foot-operated valves. This is an important time saving device as well as an aid in cleanliness. The stainless steel table design is the result of recommendations by pathology laboratory personnel. Tables and benches used for dry laboratory work are covered with formica plastic.

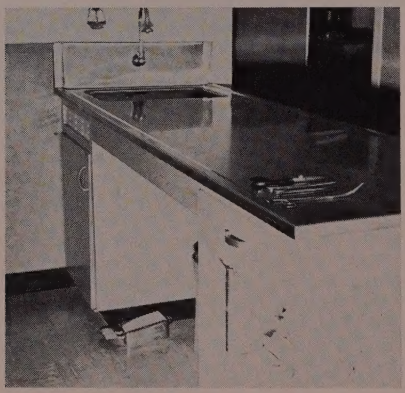


Necropsy room. Note the dark wall area. This is plastic wainscoating and is on all walls that are subject to excessive wear. The phone window provides two-room access to the telephone. This is a step saver.

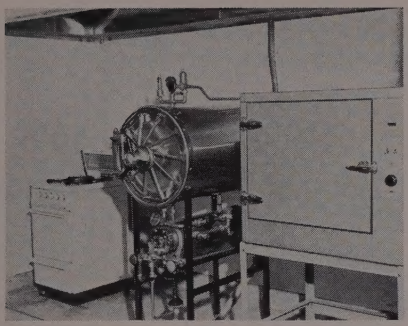


Interior of reception office. The front entrance to the building can be seen through the reception window. The reception room includes lounge facilities for the patrons, and a holding room for incoming cases.

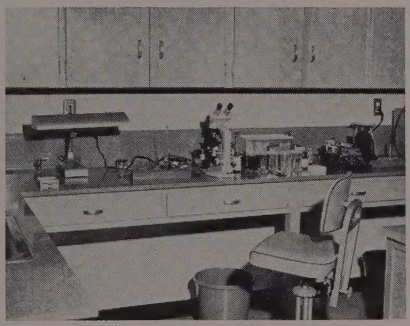
Pharmaceutical cabinet with sliding doors provides adequate storage for laboratory needs. The sink in lower right corner is stainless steel and the table top is formica.



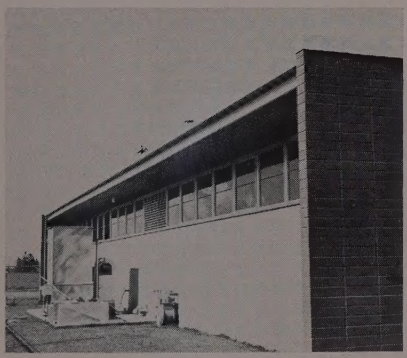
Necropsy table and sink are the result of suggested design by laboratory personnel. Note the foot-operated hot and cold water valves on the floor. Cupboard doors opposite the open area provide access to the trash storage without going around the table. Table top is of stainless steel with raised edges.



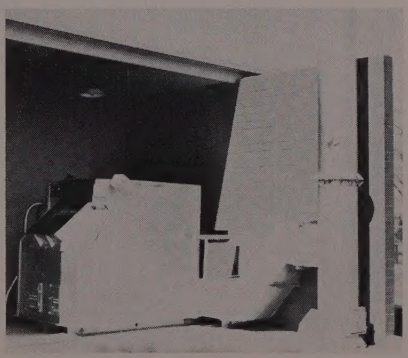
Equipment used in media room. On the left is an ordinary apartment-type gas range used for media preparation and glass sterilization. In the center is the autoclav. The cabinet on the right is an electric hot air oven. Note the air vent hood in the upper part of the photo.



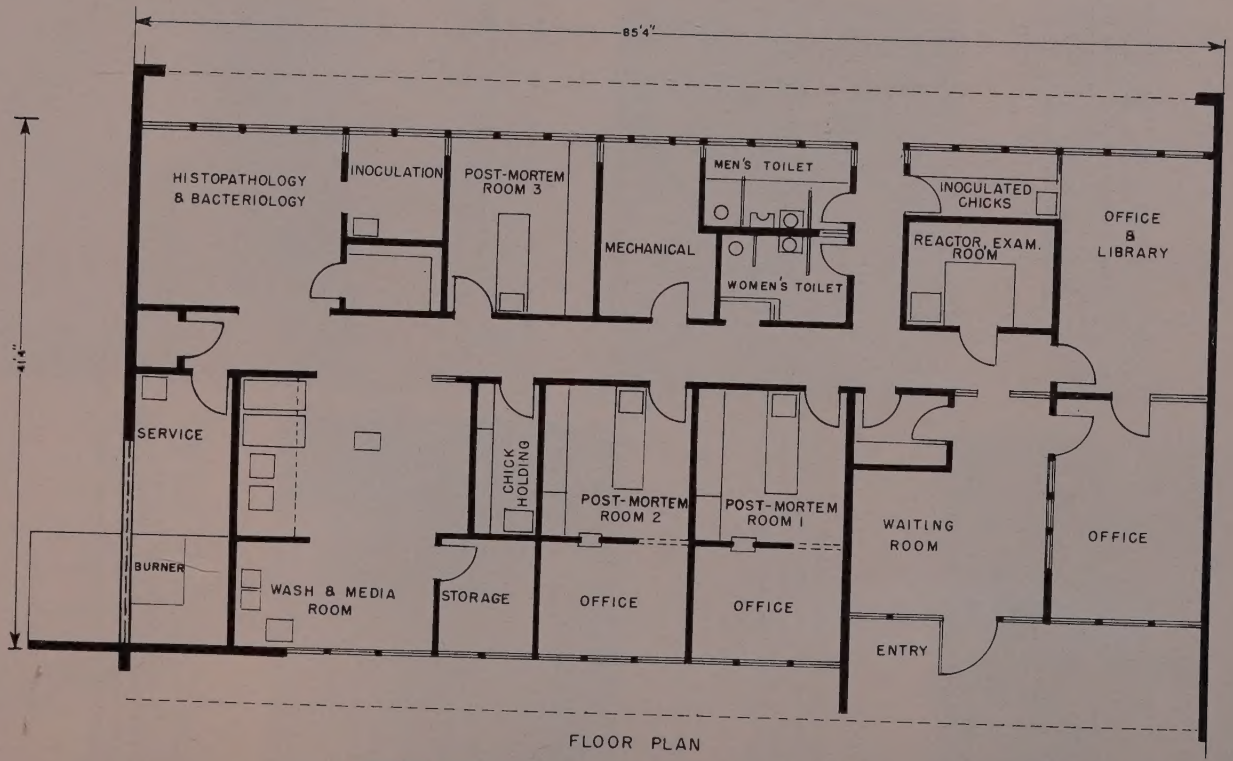
Bacteriology laboratory. The walls are of cement block. Sinks are stainless steel and work areas are covered with formica. Conveniently placed electrical outlets provide for maximum usage of all working areas.



Rear view of building showing overhanging eaves. The large piece of equipment at the center of the building is part of the laboratory cooling system.



Side view of building showing incinerator and smoke stack. The smoke stack is visible in a front view of the building. The incinerator design will handle 125 pounds of wet material per hour.



FLOOR PLAN

POULTRY PATHOLOGY LABORATORY, TURLOCK, CALIFORNIA

The old and the new. On the left is pictured the old renovated army barracks building used for 11 years. On the right is a front view of the new laboratory. The smoke stack on the left is part of the incinerator. Adequate parking is provided for laboratory patrons and personnel. The new laboratory is located on the same site as the old building.

The building is air conditioned throughout. A new system of air conditioning was installed which consists of three main air ventilation sections that completely exhaust air in contaminated or autopsy rooms approximately once every minute.

The design of the building is both modern and functional. A flat top roof with overhanging eaves provide much needed shade as temperatures in the area often exceed 100 degrees during the summer months. In addition, the entire building is insulated and further cooled by refrigeration. All windows, with the exception of the receiving room, are above eye level.

The entire flooring of the building is covered with asphalt tile except those rooms that require frequent washing such as isolation and maintenance rooms. These are concrete with floor drains.

A somewhat unique feature of the Turlock building is a separate room for the post mortem examination of reactors to the pullorum or paratyphoid tests. The reactor examination room is adjacent to the receiving room and is isolated from the rest of the laboratory in order to avoid any contamination from within the laboratory. This provides a practical aspect in that reactors may be returned to their owners for food, without danger of contamination which would render the birds unfit for consumption.

Since 1948 when work began in the temporary facilities, Turlock pathologists have described numerous poultry diseases heretofore not reported in California. Some of these are: Avian monocytosis, the identification of new Salmonellas, a preliminary report on infectious hepatitis synovitis in chickens and turkeys, and others. The laboratory, today, holds the distinction of doing the largest volume of turkey pathology work of any laboratory in the world. This may be easily understood when one considers the fact that Turlock is considered by many to be the heart of the Nation's turkey producing industry.

The Pathology Laboratories of the California Department of Agriculture are staffed by personnel from the department's Bureau of Livestock Disease Control. The staff of the Turlock laboratory includes three veterinarians, a laboratory technician, laboratory assistant, one stenographer and a janitor.

The first pathologist-in-charge of the Turlock laboratory was W. W. Worcester, D.V.M., who opened the temporary facility in January of 1948. In 1951, Dr. Worcester was transferred to the new Fresno laboratory and the Turlock position was filled for three months by W. D. Urban, D.V.M. Following Dr. Urban, S. L. Jamison, D.V.M., was assigned to be in charge. He has filled the position from 1951 to date.

This new pathology laboratory, like others in California, is a first line of defense against the inroads of dangerous foreign diseases which could mean financial disaster to the economics of California's vast poultry and turkey industry. It must be remembered, however, that the facilities in the department's poultry pathology laboratories are for practical diagnostic work and not research.

A Study on the Germination of Medusa-head Seed

By ALFRED H. MURPHY, Superintendent, Hopland Field Station, University of California
and
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Foreword

WALTER S. BALL, Chief, Bureau of Rodent and Weed Control and Seed Inspection

Medusa-head (*Elymus caput-medusae* L.) is one of the most serious range weeds in California. Due to its unpalatable characteristics and heavy seed production this pest has spread rapidly over thousands of acres of range lands in California. This paper, through the studies on the germination of medusa-head seed will be of real value to those agencies and individuals who are involved in range management and weed control.

The abundance of Medusa-head (*Elymus caput-medusae* L.) on Northern California rangeland presents a grave problem as far as adequate control is concerned. This weedy grass probably obtained its foothold in California about the turn of the century. It has since spread from the Oregon border approximately 600 miles south, as traces have been reported in Ventura County (2) (5) (7) (10). At its present rate of spread it should easily occupy most range areas of the State, where adaptable, in another 50 years.

Important as a Pest

As an undesirable range plant this grass ranks close to first place. Pryor (2) in the 1956 annual report on weeds, indicates this plant as one of the most serious range weeds. One reason for its classification as a pest is that it has little or no feed value to livestock at any stage of growth. In some cases stock will utilize the plant where the selection of other feed is limited or of poor quality This lack of use then leads to an abundance of seed available for the next growing season. Its aggressiveness is also emphasized by high seed production. Scattered plants will generally produce six or more seedheads per plant whereas in a dense stand one head per plant is the rule. This abundant seedhead production of a scattered stand helps to account for the fast buildup to a dense stand. With its aggressive habits most other useful range forage plants are soon crowded out. The plant is not selective as to site as it will grow on deep fertile soils as well as thin rocky soils. Each seed has a long rough awn which provides an excellent aid for distribution. These awns cling very well to animal fur or wool as well as clothing, thus it is easy to understand why the spread from one area to the next has been so rapid. Movement of this weedy grass can often be traced along sheep and cow trails.

Cultivated areas as well as range are susceptible to invasion by Medusa-head. Fields that have been left idle after cropping are easily infested, even areas in the Sacramento Valley have been noted. If such fields are later used for seed production or feed grain the problem of seed contamination is likely. Although control of this pest on cultivated land is easier than on range it still amounts to an additional cost for cleaning up a field.

Examination and Identification of Infested Areas

The importance of recognizing Medusa-head at an early stage of invasion cannot be overemphasized. In most cases notice is not taken of this grass until rather dense patches have developed. Usually when dense stands appear the abundance of the weedy grass will be so great that adequate control becomes more difficult. If this grass can be recognized early then the success of control can be enhanced.

Medusa-head differs from most other annual grasses in its later maturity. On Northern California ranges it is classed as an early summer maturing grass. Most of the grasses that make up the "annual type range" normally mature by May whereas Medusa-head will be green usually through June. With this differential maturity date, infestations of this plant can usually be easily distinguished by its greener color on the range.

Germination usually occurs during the first fall rains, as is common with other annual grasses, but very limited growth develops until the soil temperature warms in March and April. Heading commences in

Mature Medusa-head plants. Note the long awns which is typical of this plant.

May and then development is rapid. After the seed has matured it may stay in the head for a month or so if not dislodged by animals.

Botanically Medusa-head belongs to the genus *Elymus*, which include all perennial grasses except this one grass. It grows from 6 to 25 inches tall, depending on site, with very few leaves but with a distinctive seed-head. On the mature dry plant, the awns are often as long as four inches, spread in devious directions as compared to the straight awn when green (11). After the seeds with its long awn have dropped from the head, the remaining bristly spike often is mistaken for the weedy Mediterranean barley (*Hordeum hystrix*). Occasionally squirreltail (*Sitanion hystrix*) with its long awns is mistaken for Medusa-head but the *Sitanion* is a perennial plant and its clump-like basal development, on close inspection, will provide a good distinguishing character (4). Once a few distinct points are known early recognition will be of distinct aid in ultimate control.

Physiology Study of Medusa-head

The accumulation of information on the physiology of Medusa-head is quite limited. Sharp and Tisdale (13) and Sharp, Hironaka, Tisdale (12) reported their findings relative to some ecological and physiological conditions as they existed under Idaho range conditions. Furbush (3) indicated that fire as a method of controlling this introduced annual grass held much promise. Chemicals, such as IPC (Isopropyl-N-phenylcarbamate) and dalapon (sodium salt of 2,2-dichloropropionic acid), have been used on limited infestations but the cost to control any large acreage would be excessive.

Experimental Studies at Hopland Field Station

Experimental work with Medusa-head has been carried on by workers in the Agricultural Experiment Station of the University of California since it was recognized as a potentially serious pest on California ranges. Some of this work has been carried on at the university's Hopland Field Station situated in southeastern Mendocino County. This station is devoted to the study of the more important range problems, especially where sheep are the grazing animals. The range is situated in the inner coastal mountains approximately 40 miles inland and about 100 miles north of San Francisco. Topography varies in elevation from 500 to 3,000 feet and rainfall averages between 30 and 40 inches annually. The range vegetation is typical annual grass type with scattering of deciduous and live oaks.

With the establishment of the station in July of 1951, it was found that Medusa-head had secured a foothold in various places on the range. This was not unexpected as Furbush (3) indicated the presence of the plant approximately 20 miles north of the area in 1932. Various phases of control and experimentation have been developed since the initial establishment of the station to try to arrive at a possible method of control for this weedy range grass. The phase reported here involves some of the findings as related to seed germination characteristics under certain environmental conditions, especially burning.

Burning Technique

Controlling Medusa-head by burning was reported by Furbush (3) and Murphy (1) in the North Coastal area. This described method was used for controlling most infestations on the Hopland Field Station. Variations in control were from excellent to practically no change. As the burning attempted to destroy the seed crop apparently the variation in control was due to difference in the effect of fire on the seed.

Burning provides a relatively economical method of controlling large infestations when compared to chemical or cultivation treatment. For successful seed destruction by burning, certain burning techniques must be observed. The heat of the fire should be concentrated to burn as many seeds in the head as possible. This can be achieved by having the fire move slowly so as to obtain complete fuel consumption. The fire should then be directed toward burning downslope

Burning a dense stand of Medusa-head. Burning provides a relatively economical method of controlling large infestations.

and against the wind. The opposite of this creates a fast flash fire and many seedheads will be left unburnt. The drier the plant, yet before the seeds shatter, will probably result in the best seed destruction. Fire can be extremely tricky and if used by the inexperienced individual more damage than good can result. In California before any burning of Medusa-head on rangeland is attempted the local State Forest Ranger of the Division of Forestry should be consulted for advice and for the required burning permits.

Germination Tests

The efficiency of a burn can best be measured by the amount of seed which the fire destroys. Conducting germination tests on the seed was the measure of the effectiveness of the burn. Some initial testing of seed from burnt areas had been conducted by the State Seed Laboratory in 1951 (1).

During the germination tests it was noted that Medusa-head exhibited a tendency for dormancy. Laude (6) indicated that in some annual grasses, dormancy of fresh seed persisted from one to five months after seed maturity and dormancy also varied from year to year depending on location. One of his experiments was started to determine the length of dormancy of Medusa-head. Of the seeds collected June 14, 1952, only 4 to 6 percent germination was obtained in June and July but in October 14, 1952, 92 percent of the seed germinated.

With seed collected at Hopland on July 6, 1955, when mature, no germination occurred until 90 days later. In an attempt to break this dormancy the seed was subjected to high and low temperature durations, scarification, and cutting the seed coat. High temperatures were achieved by the use of a drying oven which had a temperature accuracy of about 2 to 4 degrees C. For low temperatures a refrigerator was used which had a temperature accuracy of about 4 to 6 degrees C. In germination, the seed was placed between wet toweling with temperatures between 30 and 38 degrees C. during the day and approximately

19 degrees C. at night. The control seed was collected in 1953 and used to insure that no other conditions except dormancy was involved in preventing germination. All treatments used in this test to break dormancy had no effect on germination.

Germinating Seeds From Burned Areas

During the summer burning of 1955 seed collections were made from nine different areas on the Hopland Field Station. All the seed showed some signs of fire damage except one collection. The burns took place during the middle of June and varied in time of burning, fuel density, general maturity of the Medusa-head, and elevation. Nine different locations were selected plus a control sample and 100 seeds were used from each location. All seeds were tested for germination by placing them between wet towels in a germinator. The control sample germinated 98 percent while all other samples showed no germination except one sample. This sample had 5 percent germination and these were the seeds that showed no appearance of burning. Most all other collected seed had the awn burnt off or the seedcoat was scorched. If the awn was burnt off the seed, no germination resulted.

Germinating Seeds From Soil Samples

Soil samples were collected from burned areas then later put into flats and watered to determine which plants would develop. Of the burned areas one was a hot burn with good accumulation of fuel while the other was burnt when some of the grass was green and the fuel accumulation was light. In the control sample, Medusa-head represented 24, 17, 42 percent of the vegetation stand in three different samples. The hot burn area showed no germination of Medusa-head. On the light fuel and some greenness the Medusa-head germination was 20, 41, and 4 percent of the vegetation stand. This test would indicate that the depression of seed germination percentage will depend on intensity of the fire or the amount of dry fuel present.

Conclusions

(1) Medusa-head represents a serious weed pest on California rangelands and early recognition of this grass will tend to aid control.

(2) Burning of Medusa-head in the dry stage offers an economical method of control. The fire attempts to destroy seed of this annual plant thus diminishing the num-

Typical dense stand of Medusa-head on open rangeland east of Garberville, Humboldt County.

ber of plants forming the next growing season.

(3) Germination tests indicated this grass to have approximately a 90-day period of delayed germination after seed maturity.

(4) Seeds showing signs of scorching or having the awn burnt off, in most cases no germination resulted.

(5) Seeds from soils in burnt area germinated greater where the burn was poor but showed no germination in a good burn.

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Hoary Cress: New Control Findings

By MURRAY R. PRYOR, Field Supervisor of Weed Control
Bureau of Rodent and Weed Control and Seed Inspection
California Department of Agriculture

The old theme that "it takes a lot of persistence and hammering away to whip hoary cress" may still be appropriate but new control findings have made the job easier.

Hoary cress, a deep-rooted perennial of wide geographical distribution, has earned the distinction of being one of California's worst weeds.

The common names hoary cress and whitetop are applied to three closely related forms: (1) *Cardaria pubescens*, or globe-podded hoary cress; (2) *C. draba*, or heart-podded hoary cress; and (3) *C. draba* var. *repens*, or lens-podded hoary cress. Although scattered in California, infestations of *C. pubescens* are comparatively rare. *C. draba* and *C. draba* var. *repens* account for most of the infested acreage.

Performance shows that *C. pubescens* is more aggressive than the other two species. It often produces two seed crops a year. *C. draba* var. *repens* is also a prolific seed producer.

Widely Distributed Pest

During 1958 a questionnaire relating to 15 weed species, including hoary cress, was submitted by the Bureau of Rodent and Weed Control and Seed Inspection to county agricultural commissioners. Answers showed the occurrence of the listed species in crop and noncrop lands. Out of 48 counties reporting, 41 reported a total of 38,048 acres of hoary cress. Of this total, 26,096 acres or 69 percent were in grain; 10,433 acres or 22 percent were in pasture or other crops; and 1,519 acres or approximately 4 percent were along roadsides and in waste places.

Scattered over the length and breadth of the State, hoary cress is a weed that grows under a wide range of conditions, such as in areas of low and high rainfall, cold and warm climates, and from low to high elevations. The largest acreages of hoary cress are found in the temperate coastal and valley regions; however, the species grows well in the arid mountain-desert areas east of the Sierras. One northern county in this geographical area reports 1,415 infested acres.

Diversity of Control Methods

The diversity of hoary cress control methods used in past years reflects the difficulties encountered in control. Even extended periods of flooding did not always result in complete control. One early test showed that 90 percent control was secured by flooding for a three-month period. Hoary cress also was tolerant to sterilants. On heavy soils, 12 to 16 pounds of sodium chlorate was necessary to kill hoary cress. Cultural practices, such as one or one and a half years of fallow followed by seeding to permanent pasture, gave satisfactory control but not eradication. A systematic cultivation program required a period of two years for eradication. Carbon bisulphide proved reasonably satisfactory for control, more so on light and medium-textured soils than heavy soils.

Seed Viability

A buried weed seed experiment initiated by the California Department of Agriculture in October, 1932, was designed to show the ability of weed seeds to live over in the soil. Tests showed that hoary cress seed had a longevity of only three to four years under irrigated and nonirrigated conditions, which indicates that hoary cress seed loses viability rather rapidly.

Amino Triazole an Effective Weapon

Generally, amino triazole, or ATA, a "nonselective" systemic herbicide, has proven more effective for hoary cress control than 2,4-D. However, evidence shows that in most cases both materials are effective when properly used. The particular advantage in using 2,4-D lies in its selectivity for cereals. It is also somewhat less expensive where control results are comparable.

Relative to comparative susceptibility of hoary cress species to systemic foliar herbicides our knowledge is limited. Weed workers in several counties report *C. pubescens* more resistant to 2,4-D and amino triazole than to the other species. Whether the tolerance is a result of inadequate wetting and penetration of the pubescent plant is not known, but such is indicated.

Heart-podded hoary cress *(Carderia draba)*.

Reports show a wide variation in ATA dosage rates for hoary cress control in the counties of the State. Dosages range from 4 to 16 pounds of the 50 percent strength product per hundred gallons of water, when applied as a wetting spray to give thorough coverage of treated plants. The common rate is four to eight pounds of the gross material per hundred gallons of solution. In Northern California rates of four to six pounds of ATA per hundred gallons of water as a herbicide for hoary cress are common, in Southern California the eight-pound rate seems to prevail. In applying the material it is customary to employ a wetting agent to facilitate wetting treated plants. Spray volume rates per acre will vary according to plant density, size, species and other factors, but 200 gallons or more of solution probably will be required. Relative to timing, the consensus is that the plant should be in vigorous growth. It is standard practice to treat from bud to blossom stage. Where general weed growth is heavy, spray operators often treat hoary cress in the blossom stage. The plant is easier to find because of its white showy flower heads.

In bureau test plot work, we have found that four to eight pounds of ATA (50 percent) per hundred gallons of water, plus a wetting agent, to be a sufficiently wide concentration range for hoary cress control. On some locations, the higher rate proves more effective, on others the lower rate has shown better control. Results indicate a correlation between dosage rates and plant growth. Apparently, more vigorous plants succumb to correspondingly lesser amounts of herbicide.

Responses to 2,4-D Herbicides

The use of 2,4-D in the emulsive acid form, when compared to various other formulations, has shown to give the best results in field trials for hoary cress control. The low volatile ester and amine forms follow in sequence; however, it takes twice as much amine as it does the ester to bring about comparable results. Two pounds of 2,4-D per acre, as the emulsive acid or low volatile ester form, is the preferred rate.

Multiple Treatments Hasten Control

Multiple treatments, where possible, have hastened control, and are highly recommended. For large scale control of hoary cress in small cereals the amine salt of 2,4-D should be used at a rate that the immature crop will tolerate. The ideal situation occurs when the crop plants are well established and in the jointing stage prior to boot formation, and when the weed is in the bud stage. If this inter-relationship does not exist, a favorable situation may occur later when the cereal is heading and in the hard-dough stage. High rates may then be used without reducing the crop yield. However, residue tolerances have not yet been established under the U. S. Food, Drug and Cosmetics Act and the situation relative to residues resulting from the late use of 2,4-D sprays has not been clarified.

Depending upon the locality and geographical latitude, hoary cress treated in grain may produce sufficient growth from new shoots to permit one or more subsequent treatments after harvest. At this point the less selective but more effective emulsive acid or low volatile ester forms of 2,4-D may be used. Where small localized or spot infestations are involved it may be desirable to hand spray the plants. Where this procedure is followed, the low volatile ester form of 2,4-D should be used at the dosage rate of two pounds of acid equivalent per hundred gallons of water, the emulsive acid form at 1½ pounds acid equivalent, and plants sprayed to wet.

In San Mateo County, Deputy Agricultural Commissioner Ian Campbell reports that spraying hoary cress in grain permits "the owner of the land to produce a grain crop each year." Small infestations are sprayed with the low volatile ester of 2,4-D at the rate of two pounds of acid equivalent per acre, large infestations are boom sprayed with the same rate of 2,4-D amine.

Chemical and Cultural Control

Deputy Agricultural Commissioner E. A. Dudley reports that in Orange County a

2,4-D application followed by cultivation gave excellent control of hoary cress. The plants are sprayed during the early blossom stage. After a lapse of three or four weeks subsequent operations involve deep chiseling followed by several discings of the treated areas.

Soil Sterilization Plus Foliage Treatments

In recent years, the effectiveness of borate and chlorate sterilants has been increased by combining them with organic chemicals, such as 2,4-D, monuron and TCA (trichloroacetate). One of these new sterilants, a 2,4-D-borate combination, has been effectively used for hoary cress control the past several years by the Shasta County Department of Agriculture. In the winter of 1957, five tons of this material, at the rate of one pound per hundred square feet, was applied to 2,000 acres of hoary cress (mainly *Cardaria pubescens*) scattered in pastures in the Fall River Mills and McArthur districts. In 1958, the reduced infestation required only 1,000 pounds of the sterilant, and during the present season it is expected that 200 pounds will suffice. To hasten control the winter soil sterilization program was supplemented by a followup 2,4-D spray program in the spring. The emulsive acid form of 2,4-D at the rate of 1½ pounds of acid equivalent per hundred gallons of water was used, the hoary cress being sprayed during the bud and blossom stages. According to Shasta County Agricultural Commissioner C. Bruce Wade, present results indicate 95 percent control.

In Tehama County a similar soil sterilization program is in effect, except for the formulation of 2,4-D used for the supplemental spray program in the spring. As in Shasta County, the hoary cress rosettes are treated in the winter with a 2,4-D-borate sterilant. However, in the spring the low volatile ester of 2,4-D, instead of the emulsive acid form, is used as a foliar spray. Tehama County Agricultural Commissioner S. T. Ancell reports that after testing all types of 2,4-D, the butoxy ethanol ester proved best.

Of the two species found in the county, *Cardaria draba* predominates. The other species, *Cardaria pubescens*, has been found to be the most difficult to control.

Dense infestation of hoary cress (*Cardaria draba*) in pasture.

Benzoic and Butyric Acid Trials

Bureau trials with trichloro-benzoic acid for hoary cress control are inconclusive due to recent and limited testing of the material; however, the compound appears promising. Preliminary results show rates ranging from 20 to 40 pounds of the acid per acre as very effective.

An experimental herbicide, the dimethyl amine salt of 2,4-D butyric acid was tried on hoary cress (*Cardaria draba* var. *repens*) in Ladino clover in Humboldt County by bureau representatives in co-operation with the county agricultural commissioner's office on May 12, 1958. The unique selectivity of the material supposedly involves the ability or inability of various broad-leaved species to transform the compound into 2,4-D by enzymatic action. Theoretically, certain legumes do not have the ability to make the conversion. Experience has shown that about twice the amount of the material, on an acid equivalent basis, is required for weed control as compared to 2,4-D.

Incidental weeds in the trial plots included plantain, dandelion, Canada thistle, bur clover and *Ranunculus spp.* A month after treatment the hoary cress showed very little effect from the various dosages, except the highest one of eight pounds of butyric acid equivalent per acre. In this plot the hoary cress manifested pronounced effects. The ladino clover showed light curling of leaves. At 1 and 2 pounds per acre, the hoary cress showed light effects; the ladino clover showed no appreciable symptoms, but the plantain and Canada thistle sustained pronounced effects. During mid-July the ladino clover was mowed precluding further readings for the season.

It is too soon to predict the outcome of the tests, but it appears that the compound is relatively selective for ladino clover and toxic to this species of hoary cress at the higher dosages tried.

Summary

1. New control findings have made easier the job of controlling hoary cress, one of California's worst weeds.

2. Hoary cress species adapted to numerous environmental conditions, are widely distributed in California. A 1958 Bureau weed questionnaire shows 38,048 acres of hoary cress in 41 counties. Sixty-nine percent was reported in grain, 22 percent in pasture and other crops, and 4 percent along roadsides or in waste places.

3. The diversity of hoary cress control methods used in past years reflects the difficulties encountered in control.

4. Buried seed germination tests indicate hoary cress seed has a rather short life, probably not more than four years.

5. Generally, amino triazole has proven more effective for hoary cress control than 2,4-D.

6. Multiple treatment procedure with 2,4-D in cereals is highly recommended.

7. Cultural methods augment chemical control.

8. A 2,4-D-borate sterilant, supplemented by a 2,4-D foliage spray program, hastens hoary cress control.

9. Trichlorobenzoic acid as a soil sterilant for hoary cress appears promising.

10. The experimental compound 2,4-D butyric acid, a selective herbicide for certain legumes, may prove a useful herbicide for hoary cress.

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Illustrated Key to the Lepidopterous Larvae Attacking Lawns in California

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Introduction

In California at the present time there are 11 known species of Lepidopterous larvae that attack lawns. They are listed below in the order as they appear in the key:

1. Hesperiidae
   Hylephila phylaeus (Drury)
2. Pyraustidae
   Nomophila noctuella (Denis and Schiffermüller)
3. Crambidae
   Crambus bonifatellus (Hulst)
   Crambus sperryellus Klots
4. Noctuidae
   Septis devastator (Brace)
   Agrotis ypsilon (Rottemburg)
   Agrotis subterranea (Fabricius)
   Pseudaletia unipuncta (Haworth)
   Laphygma frugiperda (Smith and Abbot)
   Peridroma margaritosa (Haworth)
   Laphygma exigua (Hübner)

Of these 11 species, the writer believes that *Crambus sperryellus*, *C. bonifatellus*, *Hylephila phylaeus*, *Agrotis ypsilon*, and *A. subterranea* are the most injurious. This belief is not only based upon field observations but also upon the number of specimens collected from injured lawns and submitted to our laboratory for identification from various parts of California. For the same above reasons, the writer also believes that *Agrotis ypsilon* and *A. subterranea* are the two major pests of dichondra lawns.

All the adults of the above listed species are attracted to light with the exception of *Hylephila phylaeus*.

Procedure

This key is for the identification of mature and nearly mature larvae. When examining the setal charts showing lateral views the head of the specimen is at the left of the observer; and when examining dorsal views the head is toward the observer. The illustrated mandibles are all ventral views. Many of the drawings are diagrammatic and in detail only to the extent necessary.

The following key was made as simple as possible with illustrations opposite each couplet so that there would be no difficulty in keying. After a larva is keyed, it is suggested that the specimen be compared further with additional characters which are presented in the back.

Hesperiidae

Hylephila phylaeus (Drury)
Fiery skipper

Turf hosts: Common lawn grasses, possibly preferring bentgrass and Bermuda grass.

Distribution in California: Generally in residential and agricultural areas throughout the State.

Description: Mature larva about 22 mm. long and with many short secondary setae on the dirty yellowish-brown or gray-brown body.

Head black, pitted, and with minute setae; front with two elongate reddish-brown spots at base; a reddish-brown stripe running parallel on each side of epicranial suture; adfrontal areas also reddish-brown; adfrontal sutures far from reaching vertical triangle; first five ocelli more or less evenly distributed.

Thorax with prothorax constricted; prothoracic shield narrow and reddish-brown to black throughout; prothoracic spiracles somewhat triangular in shape and larger than abdominal spiracles; a long, slender seta (occasionally broken off) arising from sclerotized ring which is located subdorsally on each side of mesothorax.

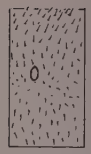
Abdomen fusiform; crotchets biordinal and arranged in a complete circle; anal proleg crotchets are triordinal in the immature specimens; anal comb with teeth, varying from 7 to 15.

Key

1. Anal comb present (A); body with many short secondary setae (B) ..... *Hylephila phylaeus* (Drury) Fiery skipper

   Anal comb not present; body without secondary setae 2


A


B

2(1). Setae IV and V adjacent (below each spiracle on the abdominal segments) (C) 3

Setae IV and V remote (IV behind and V below each spiracle) on the abdominal segments (D) 5


C


D

3(2) Triordinal crotchets on abdominal prolegs arranged in mesal penellipse (E) ..... *Nomophila noctuella* (Denis & Schiffermüller) Lucerne moth

Triordinal crotchets arranged in complete circle (F) 4

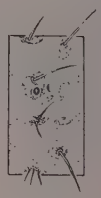

E


F

4(3). On abdominal segments 3 to 6 the pinacula of setae III do not extend down to surround spiracles (G); head light to dark chestnut-brown color with mottling ..... *Crambus bonifatellus* (Hulst) Fawn-colored lawn moth

On abdominal segments 3 to 6 the pinacula of setae III extend down to surround or nearly surround spiracles (H); head light straw color with mottling ..... *Crambus sperryellus* Klots Silver barred lawn moth


G


H

5(2). Length of spinneret about six times its width at its broadest point (I); first pair of prolegs each with 14 crotchets or less ..... *Septis devastator* (Brace) Glassy cutworm

Length of spinneret less than four times its width at its broadest point (J); first pair of prolegs each with more than 14 crotchets (except for *Agrotis subterranea* (Fabricius)) 6


I

Septis devastator


J

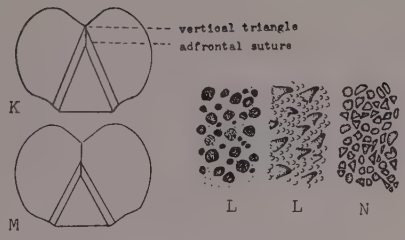
Peridroma margaritosa


J

Laphygma frugiperda

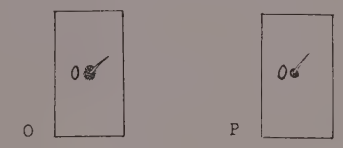
6(5). Adfrontal sutures reaching vertical triangle (K); skin granules strongly convex or conical (L) (some specimens of *Peridroma margaritosa* (Haworth) with adfrontal sutures nearly reaching vertical triangle, but smooth skin will place it in next choice) 7

Adfrontal sutures not reaching vertical triangle (M); skin smooth or with pavement-like granulation (N) 8



7(6). Skin with strong, convex granules; pinaculum of seta IV slightly taller than the height of each spiracle on abdominal segments 3 to 6(O) ... *Agrotis ypsilon* (Rottenburg) Black cutworm

Skin with conical granules; pinaculum of seta IV shorter than the height of each spiracle on abdominal segments 3 to 6 (P) ..... *Agrotis subterranea* (Fabricius) Granulate cutworm

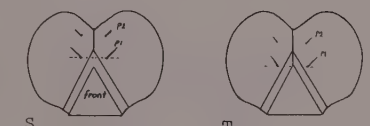


8(6). Mandible without distinct teeth on cutting margin (Q) ..... *Pseudaletia unipuncta* (Haworth) Armyworm

Mandible with distinct teeth (R) 9

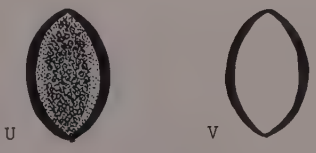
9(8). Skin pavement-like; on the head if an imaginary straight line is drawn between setae Pl, apex of front does not reach the line (S) ..... *Laphygma frugiperda* (Smith & Abbot) Fall armyworm

Skin smooth; on the head if an imaginary straight line is drawn between setae Pl, apex of front barely reaches or extends beyond the line (T) 10



10(9). Each spiracle entirely black or with central area dark brown (U) ..... *Peridroma margaritosa* (Haworth) Variegated cutworm

Each spiracle with dark peritreme with central area white (V) ..... *Laphygma exigua* (Hübner) Beet armyworm



Remarks: According to Mr. MacNeill, skipper feeding would be indicated by blades being removed from a small area allowing the basal and surface litter to show more prominently. Larvae seldom seen even though abundant. They remain concealed in silken tubes woven through the basal parts of the grass.

Other species of Hesperiids: Although *Atalopedes campestris* (Boisduval), *Paratrytone melane* (Edwards), and *Polites sabuleti* (Boisduval) are occasionally found in lawns, they are rarely of any economic importance. Mr. MacNeill believes that *Atalopedes campestris* may require slightly taller grass than normal mowed lawn to exist.

Atalopedes campestris * may be separated from *Hylephila phylaeus* in that former is free of setae on the head except for those about the mouthparts, while latter have short, almost colorless setae.

In *Paratrytone melane* the head is covered with many short setae, posterior third of prothoracic shield is black, crotchets on abdominal prolegs are weakened laterally, crotchets longer on posterior half than the ones on the anterior on each abdominal proleg. While in *Hylephila phylaeus* head with few setae, prothoracic shield black throughout and crotchets on abdominal prolegs are biordinally arranged in complete circles.

Polites sabuleti with pits on the head more or less evenly distributed and in *Hylephila phylaeus* the pits are unevenly distributed and many are almost touching each other. Suranal plate of former with three large, black blotches on the anterior and a band of black running across the posterior margin; while latter with small, black round spots unevenly scattered.

Pyraustidae

Nomophila noctuella (Denis & Schiffermüller)
Lucerne moth

Turf hosts: Bermuda grass, bluegrass, orchard grass, and white clover, preferring latter.

Distribution in California: Generally throughout the State.

Description: Mature larva about 20 mm. long and grayish or greenish in color with large dark pinacula.

Head dark brown to black, mottling noticeable in former color; ocelli 1 and 2 are larger than others; clypeus pale; adfrontal sutures reaching vertical triangle.

Thorax with black prothoracic shield cut by a pale median line; prespiracular pinaculum extending below spiracle and bearing two setae.

Abdomen with yellow-brown spiracles; setae IV and V adjacent and on same pinaculum and located below each spiracle; seta III arising from a very small pinaculum on each side of segments 2 and 7; crotchets triordinal and arranged in mesal penellipse.

Crambidae

Crambus bonifatellus (Hulst)
Fawn-colored lawn moth

Turf hosts: Common lawn grasses (probably preferring Kentucky bluegrass and bentgrass) and white clover.

Distribution in California: Generally throughout the State.

Description: Mature larva about 15 mm. long. Body grayish-white with very large pinacula.

Head light to dark chestnut-brown and mottled; adfrontal sutures not reaching the vertical triangle; ocelli 3 and 4 nearly touching each other, ocelli 2 closer to 3 than 1; slender spinneret definitely longer than labial palpi.

Thorax with yellow-brown prothoracic shield cut by one median pale line; prespiracular pinaculum extending below the spiracle and bearing two setae.

Abdomen with spiracles light brown within and peritremes black; setae IV and V adjacent and on same pinaculum on segments 1 to 8; prolegs with triordinal crotchets arranged in complete circles.

Remarks: Bohart (1947) observed that mature larvae notched the edges of grass and often severed the blades completely and drew them into the shelters to be consumed.

Crambus sperryellus Klots
Silver-barred lawn moth

Turf hosts: Common lawn grasses (probably preferring Kentucky bluegrass and bentgrass) and white clover.

Distribution in California: Generally throughout the State.

Description: Same as *C. bonifatellus* except for head being light strawcolored and mottled; small, dark, irregular sclerotized area present behind each spiracle and pina-

* Not possesing any specimen of this species, character was obtained from Comstock (1930).

culum of seta III extending down to surround each spiracle on abdominal segments 3 to 6.

Noctuidae

Agrotis subterranea (Fabricius) (Feltia)

Granulate cutworm

Turf hosts: Common lawn grasses, dichondra, and white clover.

Distribution in California: Generally throughout the State.

Description: Mature larva about 30 to 40 mm. long. Body color dark gray with venter pale greenish-gray. Skin granules bluntly conical.

Head light brown, roughened, and with reticulation; submedian arcs black; adfrontal sutures reaching vertical triangle.

Thorax with dark brown prothoracic shield; prespiracular pinaculum bearing two setae.

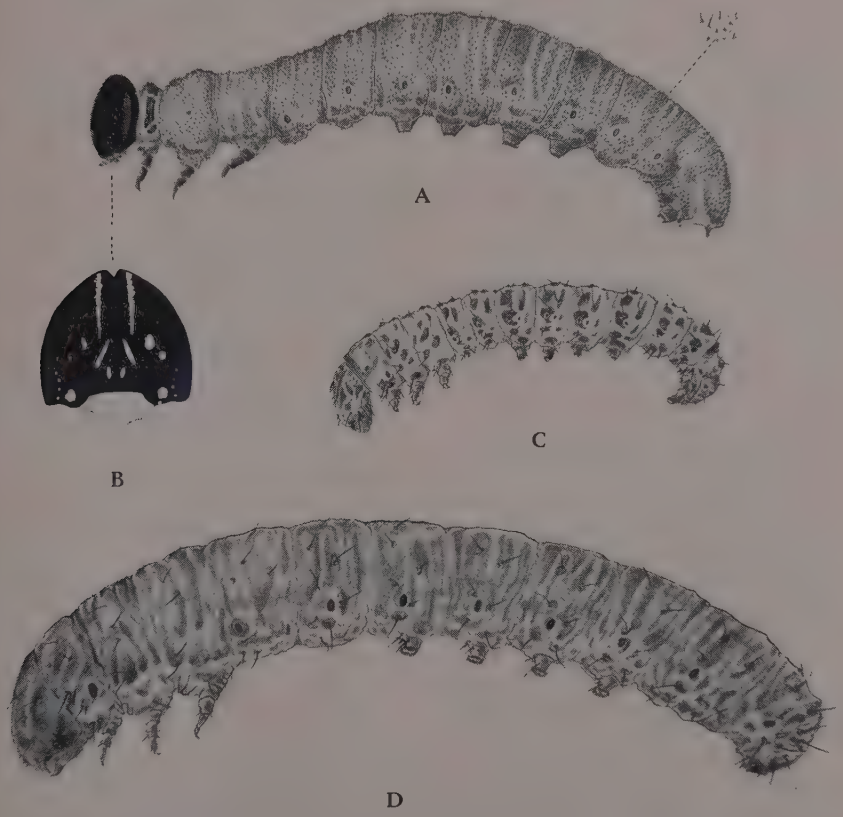
Abdomen with black spiracles; seta IV directly behind and V below each spiracle except segment 7; pinaculum of seta IV shorter than the height of each spiracle on segments 3 to 6; crotchets uniordinal and in mesoseries; first pair of prolegs each with 12 crotchets or less.

Agrotis ypsilon (Rottemburg)

Black cutworm

Turf hosts: Common lawn grasses, dichondra, and white clover.

Distribution in California: Generally throughout the State.



A. *Hylephila phylaeus* (Drury). B. *H. phylaeus*. Frontal view of head. C. *Crambus sperryellus* Klots. D. *Agrotis ypsilon* (Rottemburg).

Drawings, courtesy of California Spray Chemical Co.

Description: Mature larva about 30 to 45 mm. long. Body light gray to nearly black and covered with convex, rounded granules.

Head rough and brownish with black submedian arcs, and with reticulation; adfrontal sutures reaching vertical triangle.

Thorax with brown prothoracic shield; prespiracular pinaculum bearing two setae.

Abdomen with black spiracles; pinaculum of seta IV slightly taller than each spiracle on segments 3 to 6; seta IV directly behind and V below each spiracle except segment 7; crotchets uniordinal and in mesoseries.

Laphygma exigua (Hübner)

Beet armyworm

Turf hosts: Common lawn grasses and dichondra.

Distribution in California: Generally throughout the State.

Description: Mature larva about 25 mm. long. General color from pale green to brown. Skin smooth.

Head yellowish-brown with reticulation; adfrontal sutures not reaching vertical triangle.

Thorax with light to dark brown prothoracic shield cut by a median and two lateral pale lines; prespiracular pinaculum bearing two setae; usually a dark spot is present on each side of mesothorax.

Abdomen with spiracles white or yellowish within and peritremes black; seta IV directly behind and V below each spiracle except on segment 7; a small pale spot dorso-posterior to each abdominal spiracle; crotchets uniordinal and in mesoseries.

Laphygma frugiperda (Smith & Abbot)

Fall armyworm

Turf hosts: Bentgrass, Bermuda grass, bluegrass and white clover.

Distribution in California: In counties south of Tehachapi Mountains.

Description: Mature larva about 30 mm. long with pavement-like skin. General color varying from pinkish through yellowish, olivaceous and dull gray to almost black.

Head yellowish or brownish with reticulation; submedian arcs dark brown; adfrontal areas white; adfrontal sutures far from reaching vertical triangle; ocelli 4 smaller than others.

Thorax with dark brown prothoracic shield, cut by one median and two lateral pale lines; prespiracular pinaculum bearing two setae.

Abdomen with spiracles light brown within and peritremes black; seta IV directly behind and V below each spiracle except on segment 7; pinacula round and dark brown; crotchets uniordinal and in mesoseries.

Remarks: This species is very destructive to lawns in other states but so far a minor lawn pest in California.

Peridroma margaritosa (Haworth)

Variegated cutworm

Turf hosts: Bentgrass and white clover. Since this species is a general feeder it will probably attack other common lawn grasses.

Distribution in California: Generally throughout the State.

Description: Mature larva about 35 to 46 mm. long with smooth skin. Body color varying from pale gray to a dark mottled brown intermixed with red and yellow. Yellow or orange mid-dorsal spots present on the third thoracic and at least on the first four abdominal segments.

Head smooth, light to dark brown in color with reticulation; submedian arcs black; adfrontal sutures not quite reaching vertical triangle.

Thorax with dark brown prothoracic shield; prespiracular pinaculum bearing two setae.

Abdomen with posterior extremity enlarged; a black W-shaped mark open anteriorly on dorsum of segment 8; spiracles dark brown to black; seta IV directly behind and V below each spiracle except on segment 7; crotchets uniordinal and in mesoseries.

Pseudaletia unipuncta (Haworth) (*Cirphis*)

Armyworm

Turf hosts: Common lawn grasses and clover.

Distribution in California: Generally throughout the State.

Description: Mature larva about 30 to 35 mm. long. Ground color yellowish or gray and more or less tinged with pink. Skin smooth.

Head cream to light brown with dark reticulation; submedian arcs dark brown; length of front less than the length of epicranial suture; adfrontal sutures far from reaching vertical triangle; mandible without distinct teeth on cutting margin.

Thorax with brown prothoracic shield cut by one median and two lateral white lines;

prespiracular pinaculum with two setae. Abdomen with spiracles black; seta IV behind and V below each spiracle except on segment 7; crotchets uniordinal and in mesoseries.

Septis devastator (Brace) (*Crymodes*)
Glassy cutworm

Turf hosts: Prefers bluegrass but will attack other common lawn grasses.

Distribution in California: Generally throughout the State north of Tehachapi Mountains.

Description: Mature larva about 35 to 40 mm. long. Body a dirty whitish color. Skin obscurely pavement-granulose.

Head reddish-brown; adfrontal sutures reaching vertical triangle; spinneret about six times as long as broad.

Thorax with brown prothoracic shield cut by a light median line; prespiracular pinaculum bearing two setae.

Abdomen with spiracles brown within and peritremes black; seta IV directly behind and V below each spiracle except on segment 7; pinacula concolorous with adjacent areas; first pair of prolegs each with 14 crotchets or less, uniordinally arranged and in mesoseries.

Remarks: This species works below surface of the ground and feeds upon roots.

Acknowledgments

I wish to express my thanks to Mr. Richard F. Wilkey of the California Department of Agriculture for illustrating many of the key characters. I am also indebted to Mr. C. Don MacNeill of the California Academy of Sciences for his helpful information on the family Hesperiidae and for loan of specimens. Thanks also to Dr. Roland N. Jefferson and Mr. John M. Burns of the University of California and Mr. Joe Kiyota of Sacramento for donations or loans of materials. Mrs. Iris Savage's suggestions and criticisms have been appreciated.

The full lateral larval drawings of *Hylephila phylaeus*, *Crambus sperryellus*, *Agrotis ypsilon* and the head of the first species were loaned by the California Spray-Chemical Corporation of Richmond, California, to whom I am very grateful.

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PRODUCTION AND VALUE OF PRINCIPAL PRODUCTS OF CALIFORNIA FARMS*

1957 (Revised) and 1958 (Preliminary)

Commodity	Acreage[1] 1957	Acreage[1] 1958	Unit	Production 1957	Production 1958	Value[2] 1957	Value[2] 1958
Dairy products			lbs. (sold)	7,423,000,000	[3]	355,994,000	[3]
Cattle and calves			lbs. (sold)	1,788,670,000	[3]	343,682,000	[3]
Cotton lint	711,000	732,000	bales	1,537,000	1,600,000	258,400,000	271,235,000
Cottonseed			tons	613,000	648,000	32,366,000	27,864,000
Hay	2,006,000	2,007,000	tons	6,837,000	6,963,000	153,149,000	153,186,000
Grapes	399,000	399,200	tons	2,382,000	2,666,000	142,005,000	168,292,000
Eggs (chicken)			(No. sold)	4,497,000,000	[3]	138,283,000	[3]
Oranges	148,618	146,100	boxes (77 lbs.)	35,420,000	22,830,000	102,092,000	105,010,000
Tomatoes	167,100	185,000	tons	2,325,800	2,917,000	92,597,000	105,508,000
Lettuce	134,600	111,900	cwt.	20,259,000	17,817,000	83,978,000	64,587,000
Barley	1,967,000	1,849,000	bu. (48 lbs.)	78,680,000	67,488,000	77,106,000	70,862,000
Turkeys			No. (sold)	14,618,000	[3]	58,905,000	[3]
Peaches	78,899	81,500	tons	791,000	737,000	49,946,000	46,533,000
Potatoes	113,700	122,000	cwt.	31,150,000	29,458,000	47,774,000	52,138,000
Sugar beets	197,000	190,000	tons	4,314,000	3,724,000	47,751,000	42,826,000
Rice	226,000	255,000	cwt.	9,718,000	11,730,000	43,537,000	49,852,000
Chickens and broilers			lbs. (sold)	207,069,000	[3]	39,159,000	[3]
Lemons	51,108	52,500	boxes (79 lbs.)	16,200,000	16,900,000	36,774,000	34,814,000
Celery	17,300	16,700	cwt.	8,734,000	8,222,000	33,813,000	35,924,000
Prunes	84,884	85,600	tons	165,000	96,000	33,165,000	35,520,000
Strawberries	20,700	16,800	lbs.	223,560,000	215,040,000	32,120,000	33,878,000
Dry beans	267,000	298,000	cwt.	3,596,000	4,091,000	30,206,000	33,955,000
Carrots	23,400	21,700	cwt.	6,006,000	5,438,000	29,384,000	24,032,000
Sheep and lambs			lbs. (sold)	148,788,000	[3]	27,928,000	[3]
Cantaloupes	38,500	46,100	cwt.	5,673,000	6,378,000	26,979,000	22,699,000
Corn	259,000	238,000	bu. (56 lbs.)	19,166,000	17,374,000	26,641,000	24,324,000
Pears	38,691	40,000	tons	403,000	344,000	26,276,000	28,880,000
Walnuts	118,746	121,400	tons	61,300	78,000	26,175,000	28,860,000
Alfalfa seed	188,000	162,000	lbs.	84,600,000	63,180,000	21,911,000	20,218,000
Asparagus	75,800	76,300	cwt.	1,895,000	1,831,000	19,886,000	20,481,000
Almonds	88,212	88,400	tons	37,500	20,000	18,938,000	14,880,000
Hogs			lbs. (sold)	93,976,000	[3]	18,845,000	[3]
Apricots	36,719	36,500	tons	167,000	90,000	17,034,000	14,220,000
Grain sorghum	236,000	270,000	bu. (56 lbs.)	13,216,000	15,390,000	16,124,000	18,468,000
Wheat	283,000	371,000	bu. (60 lbs.)	6,226,000	8,162,000	13,137,000	14,692,000
Plums	22,340	23,300	tons	78,000	63,000	12,792,000	10,269,000
Wool[4]			lbs.	17,560,000	[3]	12,555,000	[3]
Onions	11,000	12,900	cwt.	3,943,000	3,785,000	10,832,000	7,945,000
Snap beans	7,800	7,800	tons	52,700	55,200	10,769,000	9,826,000
Apples, com'l, counties	21,041	21,350	bu. (48 lbs.)	8,950,000	9,300,000	10,740,000	10,230,000
Cherries	9,429	9,800	tons	30,900	12,000	8,806,000	4,932,000
Olives	27,859	27,900	tons	37,000	70,000	8,732,000	7,420,000
Broccoli	24,500	24,800	cwt.	1,172,000	1,356,000	8,491,000	10,486,000
Sweet potatoes	13,000	12,000	cwt.	975,000	1,020,000	7,615,000	7,650,000
Watermelons	18,700	19,200	cwt.	2,792,000	2,611,000	7,319,000	6,602,000
Sweet corn	18,500	20,500	cwt.	1,438,000	1,537,000	6,968,000	6,514,000
Avocados	19,794	21,000	tons	15,800	42,000	6,952,000	8,568,000
Green lima beans	29,900	23,700	tons	45,600	40,530	6,690,000	5,954,000
Cauliflower	12,800	12,600	cwt.	1,932,000	1,954,000	5,659,000	6,517,000
Oats	223,000	196,000	bu. (32 lbs.)	7,582,000	6,076,000	5,383,000	4,435,000
Nectarines	4,749	6,000	tons	36,000	29,000	5,328,000	4,379,000
Figs	21,570	21,600	tons	78,100	80,900	5,036,000	6,115,000
Bell peppers	4,000	4,600	cwt.	560,000	644,000	4,928,000	5,410,000
Honeydew melons	6,500	6,250	cwt.	960,000	979,000	4,917,000	4,240,000
Grapefruit	7,503	7,700	boxes (65 lbs.)	2,407,000	2,397,000	4,904,000	6,029,000
Cabbage	9,400	10,700	cwt.	2,266,000	2,884,000	4,802,000	8,009,000
Cucumbers	6,500	6,300	tons	63,660	59,690	4,535,000	4,247,000
Flaxseed	35,000	45,000	bu. (56 lbs.)	1,295,000	1,642,000	4,209,000	5,090,000
Hops	5,600	5,900	lbs.	6,832,000	9,027,000	3,963,000	5,416,000
Brussels sprouts	5,300	4,500	cwt.	556,000	472,000	3,772,000	3,769,000
Honey			lbs.	22,360,000	44,720,000	3,086,000	5,724,000
Green peas	14,300	10,900	tons	24,550	14,450	3,052,000	1,800,000
Artichokes	9,400	9,400	cwt.	329,000	329,000	2,891,000	3,361,000
Spinach	11,700	9,100	tons	81,900	59,700	2,834,000	2,440,000
Dates	4,667	4,600	tons	23,300	17,700	2,633,000	2,354,000

PRODUCTION AND VALUE OF PRINCIPAL PRODUCTS OF CALIFORNIA FARMS—Continued

1957 (Revised) and 1958 (Preliminary)

Commodity	Acreage[1]		Unit	Production		Value[2]	
	1957	1958		1957	1958	1957	1958
Dried chili peppers	4,030	4,250	tons	5,440	5,650	2,328,000	2,430,000
Garlic	2,300	2,900	cwt.	196,000	203,000	1,812,000	2,094,000
Sudan grass seed	22,000	6,500	lbs.	29,040,000	9,000,000	1,249,000	630,000
Persian melons	2,000	1,600	cwt.	200,000	176,000	1,080,000	871,000
Ladino clover seed	11,000	12,000	lbs.	2,640,000	3,600,000	766,000	1,872,000
Red clover seed	5,000	3,600	lbs.	1,850,000	1,800,000	581,000	639,000
Purple vetch seed	36,000	30,000	lbs.	9,360,000	6,600,000	524,000	502,000
Dry field peas	5,000	1,000	cwt.	71,000	11,000	390,000	74,000
Alsike clover seed	4,400	3,000	lbs.	1,760,000	1,200,000	317,000	234,000
Beeswax			lbs.	447,000	984,000	255,000	433,000
Persimmons	538	500	tons	2,800	2,200	185,000	205,000
Pomegranates	551	600	tons	2,600	2,700	166,000	197,000
Rye	10,000	10,000	bu. (56 lbs.)	130,000	130,000	131,000	140,000
Merion blue grass seed	760	250	lbs.	141,000	90,000	116,000	122,000
Common vetch seed	1,000	1,000	lbs.	500,000	470,000	28,000	28,000
Mohair			lbs.	32,000	[3]	22,000	[3]
Mustard seed	250	400	lbs.	310,000	260,000	17,000	26,000

* Compiled by the California Crop and Livestock Reporting Service, Bureau of Agricultural Statistics, California Department of Agriculture.

[1] Bearing acreage of fruit crops. Harvested acreage of other crops.

[2] For livestock and livestock products data are cash receipts for the calendar year. Crop values relate to value of production and are on a crop year basis.

[3] Livestock data for 1958 available in May, 1959.

[4] Wool data for marketing season April-March.

NOTE: The above data do not provide a complete record of all agricultural products in California because official estimates of many minor crop and livestock enterprises are not available. These data should not be used to compute farm income since they include duplication between livestock items and the value of home-grown feeds used in their production.

The Use of Foliar Gland Characters in the Identification of Peach and Nectarine Varieties in California[1]

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When commercial peach growing began in the United States in the late eighteenth and early nineteenth centuries relatively few varieties were grown. As the industry gradually expanded to include nectarines and spread from its place of origin in the Eastern states, there was a continual need for new varieties that were adaptable to new environmental conditions. Not only did the peach tree breeder have to select for adaptability to different climates, but also for the changing market requirements and for disease resistance. This continued expansion of the peach and nectarine industry has resulted in the development of numerous varieties. Because of the confusion resulting from the increase in varieties, inadvertent mislabeling of varieties has become more frequent. The propagator, nurseryman, horticulturist, breeder and the nursery inspector all are faced with the problem of maintaining the identity of the hundreds of varieties now being propagated or maintained for breeding purposes.

The stems, buds, leaves, flowers and fruits provide the best characters for identifying the peach and nectarine varieties (4). For positive identification, one or more of these characters must be employed. The flower, fruit, and foliage characters are present during the growing season and are more dependable and more commonly used for identification than stems and buds. In most instances, identification as to variety during the dormant period is impractical, if not impossible. Because of the difference in the duration and the time of appearance, the flower, fruit and foliage characters cannot be observed simultaneously. Since leaves are more numerous and are present during the longest period of the year, foliar characters are used more frequently. Flowers and fruits do not commonly occur in nursery row stock, thus only foliar characters are available when the identity of growing nursery stock is concerned.

This paper is concerned only with the small organs or foliar glands which occur on the petioles and basal margins of the leaf blade (Fig. 1A, B). The first published recognition of the foliar glands of peach is credited to Desprez in 1810 (16). According to Gregory (19), one British and two French workers first used foliar gland characters for the classification of peach varieties as early as 1820. These three workers recognized the same three leaf types as are recognized today, namely those with globose glands, those with reniform glands, and those without glands (eglandular).

Subsequent to 1820, various references to the foliar glands have appeared in the literature. Some have been technical investigations on the glands, whereas others have made reference only to the gland types of certain varieties. Gregory (19) made the first thorough investigation relative to the taxonomic value and structure of the peach leaf glands. In addition to the three previously recognized leaf types, he recognized a fourth group consisting of the indistinct varieties. These types he considered to be "mixed" or on the borderline between reniform and globose, as both types of glands could be found on the same tree. The genetical evidence of various authors (2, 3, 14, 15, 16, 17, 28) has given credence to the classification of leaves into three types—reniform, globose, and eglandular—but not to Gregory's "mixed" group. The results of their breeding work have demonstrated the inheritance of the three recognized leaf types. When varieties with reniform glands are selfed or crossed by others with reniform glands they yield seedlings all of which have reniform glands. Similarly, eglandular varieties when selfed or crossed

[1] Part of the information in this paper was obtained through work done under Agricultural Marketing Service Project number SDA-Calif.-A-2, for which state funds were matched with federal funds received from the Agricultural Marketing Service, U. S. Dept. of Agriculture, under provisions of the Agricultural Marketing Act of 1946.

by others with eglandular leaves give rise to seedlings all of which have eglandular leaves. Varieties with reniform glands crossed by others that are eglandular yield seedlings all of which have globose glands. When a globose gland variety, such as Lovell, is selfed or crossed with others having globose glands, all three gland types are represented in the resulting seedlings.

In addition to the three recognized types, genetical evidence (2) has indicated another gland type which closely resembles the small, reniform gland type, but does not produce only reniform progeny when selfed. This type, which has been reported only for the Gold Drop variety, is apparently very rare and has not been included in the classification used in this paper.

Aside from the rare instance of small reniform type of glands reported for Gold Drop variety, the majority of the peach and nectarine varieties can be classified readily into one of the three categories. Exceptions are those varieties of the fourth group recognized by Gregory, in which the glands are mixed or indistinct. Although there is no genetical basis reported for such a mixed type, the present authors, like Gregory, found in the field that there are certain varieties in which the glands are not distinct and it is difficult to determine whether they are reniform or globose. The authors have classed such varieties as reniform whenever reniform glands could be found on the tree, regardless of the fact that globose glands also appeared to be present on the same tree.[2]

Determining the leaf gland type of some varieties has been difficult. Comparison of the leaf gland types reported by various authors and in patented variety descriptions have shown many disagreements. Most of these disagreements involved reniform and globose types. No doubt some of these disagreements are the result of inadvertent variety substitution whereas others are variations in individual interpretation of the "mixed" type.

The accompanying list includes 469 varieties of which 402 are peach and 67 are nectarine; a total of 330 have reniform glands, 116 have globose glands and 23 are eglandular. The eglandular varieties are usually subject to infection by powdery mildew (2, 35) and also have been reported to be more susceptible to damage by eriophyid mites (24, 25), hence most hybridizers attempt to eliminate them early in their selective breeding work. However, the eglandular varieties have been reported to be less susceptible to peach leaf curl infection than those with globose or reniform glands (1, 35).

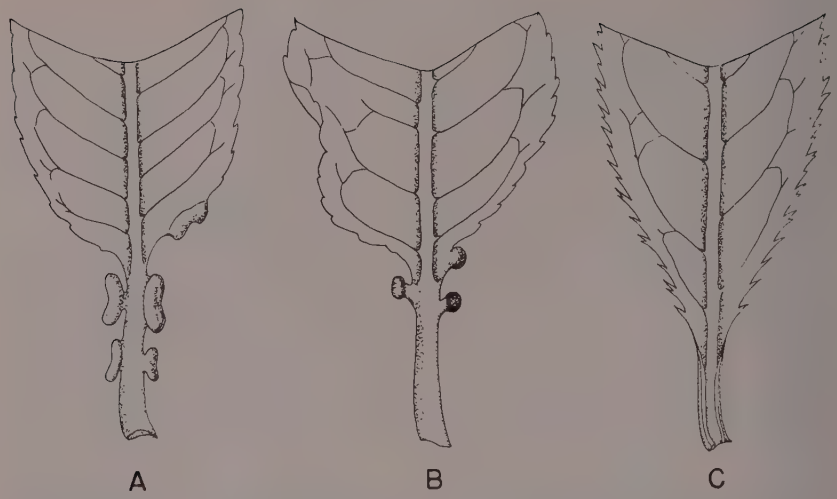
[2] This method of classification was adopted at the suggestion of Dr. J. H. Weinberger, Principal Horticulturist, U. S. Horticultural Fld. Sta., Fresno, California.

Use of Gland Characters

Most California nurserymen maintain individual records of the gland characters of those varieties which they commonly propagate. They use gland characters not only as a clue for checking the identity of their growing nursery stock, but also while collecting propagating wood. Mistaken identities occur, for the most part, during the collection of budwood and scionwood. Many commercial plantings, which serve as nursery budwood sources, consist of adjacent blocks of several varieties. Not only does the budwood collector check individual trees for the correct gland character, but also frequently uses the gland type to establish the limits of specific variety blocks. Checking individual trees for the gland type is important in avoiding variety mixtures resulting from previous mistakes and in avoiding off-variety limbs that have developed from understock sprouts and possibly also mutants or bud sports (29).

One nurseryman has been reported to provide his customers the added service of leaf-checking previously sold trees for the purpose of detecting off-varieties. Such inspections are made during the first growing season after the trees are planted in the orchard. When off-varieties are found, the nurseryman field-grafts them to the desired variety, thus retaining good customer relationship by reducing losses to the fruit grower. The regrafting or replacing of variety mixtures is an added expense to the nurseryman, thus it is to his advantage to avoid variety mixups.

There are numerous varieties with the same gland character, therefore, off-varieties in the nursery or in the orchard can be detected by this method only when they have gland characters that are not correct for the desired variety. Investigations of the budwood sources used in propagating the questioned variety may sometimes disclose the true identity. The economic losses are greatest when the variety mixups are discovered after the trees have been grown to the fruiting age.



The three leaf types found in peaches and nectarines. A—Reniform glands and crenate leaf margins. B—Globose glands and crenate leaf margins. C—Eglandular (glandless) type with serrate leaf margins. Redrawn by A. A. Millecan from Cullinan (18).

In addition to the detection of pests, the nursery inspector also is concerned with trueness to variety. He must rely entirely upon foliar characters as a clue to identity, as flowers and fruits are absent in growing nursery stock.

Source of Data

The writers became aware of the usefulness of the gland characters while inspecting budwood sources and nursery stock for virus diseases. Although the gland characters of certain varieties have been published by a number of workers, there was no single list which treated the majority of varieties found in California. Data for the list given in this paper have been gathered from numerous sources. Various reports in the literature have provided the gland characters of the older and popular varieties (1, 13, 20, 21, 32, 33), as well as many of the recently introduced varieties (22, 23, 26, 27, 30, 31, 34, 36). These data along with information provided by a number of nurserymen formed a "working" list that the writers have used for six years. Additional data were obtained through field observations and from many contributors including horticulturists, breeders, and various persons concerned with the introduction of new varieties. Variety blocks maintained by workers of the U. S. Department of Agriculture and the University of California Agricultural Experiment Station provided a means of checking many of the obscure varieties. In some instances, gland characters have been obtained from the botanical descriptions of patented varieties. Unfortunately, in many instances this information has been omitted in the patented variety descriptions. Wherever possible, varietal names and synonyms used correspond to those listed in the "Register of New Fruit and Nut Varieties" (5, 6, 7, 8, 9, 10, 11, 12). Since flowering peach varieties also are grown by a number of California nurserymen, they also are included in the list and are designated by "(Fl.)" after the name.

Foliar Gland Characters in Peach and Nectarine Varieties

PEACHES

Variety	*Gland Type**
Afterglow	R
Alamar	R
Alexander	G
Altair	R
Alton *(Minnie)*	R
Amador	G
Ambergem	R
Anaheim	R
Andora	R
Anna	R
Anza	R
Arp Beauty *(Arp)*	R
Australian Saucer	R
Autumn *(New Jersey 145)*	G
Babcock	G
Balfour	E
Barbara	R
Bates	R
Bella Rosa	R
Belle of Georgia *(Belle)*	R
Blake *(New Jersey 117)*	R
Blazing Gold *(S-47-3)*	R
Blood Cling	R
Blood Free	R
Bobolink	R
Bokhara	R
Bonita	R
Brackett	R
Brentwood	G
Burbank Giant	R
Buttercup	R
C. O. Smith	R
Candoka	R
Cardinal	G
Carman	R
Carmichael	G
Carolyn	G
Chaffey	R
Champion	G
Cherryred *(New Jersey 129)*	R
Constitution *(New Jersey 161)*	R
Corona	G
Coronado *(USDA W 38-39B)*	G
Coronet *(USDA FV 126-79)*	R
Cortez	G
Cumberland	R
Curlew	R
Curry Free *(Currie Free)*	R
Dahling Cling	E
Decker	G
Delicious	R
Dixon 1 *(Dix 6-6)*	R
Dixon 2 *(Dix 6-8)*	G
Dixigem	R
Dixired	G
Double Red (Fl.)	G
Double White (Fl.)	R
Dripstone	R
Duke of Georgia	G
Earligold	R
Early Babcock	G
Early Crawford	G
Early Double Red (Fl.)	G
Early East *(New Jersey 134)*	R
Early Elberta, Gleason Strain	R
Early Halehaven	G
Early Flame	R
Early Gold Dust	R
Early Halford	G
Early Hiley	R
Early Kirkman	R
Early Rochester	R
Early Triogem	R
Early Wheeler	R
Early White Giant	R
Eclipse	R
El Solyo	G
Elberta	R
Elberta Cling	R
Ellis	G
Envoy *(New Jersey 102)*	R
Erli-Berta	R
Erly-Red-Fre *(All-Red-Free)*	R
Erlyvee	R
Evalyn Gem	R
Eve	R
Fairberta	R
Fair Beauty	R
Fairhaven	G
Fairida	R
Fay Elberta	R
Fertile Hale *(Perfect Hale)*	R
Fidler	R
Fireball *(False Sunhigh)*	G
Fireglow	R
Fisher	R
Fitzgerald	G
Flaming Gold *(Burbank's Fuzzless)*	R
Flamingo	R
Florence	R
Floretta	R
Flory Dwarf	R
Fontana	R
Fortuna	R
Foster	G
Fowler	R
Four Star	G
Frank	R
Freeland	R
Frye Cling	E
Fulmur	R
Gage *(Gage Elberta)* *(Dwarf Elberta)*	R
Gaume *(Gaum)*	R
Giant Babcock	R
Giant Snowball	R
Giblin	G
Gold Drop	R
Gold Dust *(Stribling S-47-4)*	R
Gold Medal	R
Goldfinch	R
Goldeneast *(New Jersey 87)*	R
Golden Blush	R
Golden Early Bird	R
Golden Flame	R
Golden Globe	G
Golden Elberta Cling	R
Golden Jubilee	R
Golden State	R
Goldray	R
Gomes *(Stuart-Gomes)*	G
Goodcheer *(New Jersey 152)*	R
Greensboro	R
Halate	G

* R=Reniform, G=Globose, E=Eglandular

Foliar Gland Characters in Peach and Nectarine Varieties—Continued

Variety	*Gland Type*
Hal-Berta Giant	G
Hale Early	G
Hale Harrison Brilliant	R
Halhaven *(Globe Haven)*	G
Halford 1 *(McKnight Cling)*	R
Halford 2	G
Halford 3	E
Hardee	R
Harris Elberta	G
Hauss	E
Heath	R
Helen Borchers (Fl.)	R
Herb Hale	R
Hermosa	R
Hiland	G
Hiroaka Flame	R
Hiley *(Early Belle)*	R
Hinners Hale	R
Hoffman	E
Honeyberta	R
Honey Dew Hale	R
Honeygem	R
Indian Blood Cling	R
Indian Blood Free	E
J. H. Hale	R
J. L. Ames *(Ames Elberta)*	R
Jerseyland *(New Jersey 135)*	R
Johnson	G
July Elberta	R
Burbank Elberta	
Brentwood Beauty	
Early Elberta	
Jewell	
Kim Early Elberta	
Stark's Early Elberta	
July Gold	R
July Queen	R
Jumbo	R
June Elberta *(Mikado)*	R
June-Berta	R
June Gold	G
Kalhaven	R
Keystone	G
Kim Earling	E
Kirkman Gem *(Late Rio Oso Gem)*	R
Krummel October	R
Late Champion	R
Late Crawford	G
Late Double Red (Fl.)	G
Late Elberta	R
Late Gold	R
Late Haven	R
Late John Gee *(John D)*	R
Late Kirkman	R
Laterose *(New Jersey 109)*	R
Leader	R
Leeton	R
Lemon Cling	R
Lemon Free	R
Lettie	R
Levi *(Henrietta)*	R
Libbee	R
Lizzie	R
Loadel	G
Loring	G
Los Angeles	R
Lovell	G
Lukins Honey	R
Lyman Late	R
Marigold	R
Maxine	G
Maybelle	R
Mayflower	G
Maygold *(USDA FV 132-12)*	R
McKevitts	G
McGuigan	R
Meadow Lark	G
Melrose	R
Merriam	G
Merrill 49'er	R
Merrill Aurora	R
Merrill Beauty	G
Merrill Bonanza	R
Merrill Brilliant	R
Merrill Christmas	R
Merrill Dandy	R
Merrill Delicious	G
Merrill Fiesta	R
Merrill Gem	R
Merrill Gemfree	R
Merrill Glory	R
Merrill Gold Rush	R
Merrill Hale	R
Merrill Halloween I	R
Merrill Halloween II	R
Merrill June	R
Merrill Late Canner	G
Merrill Late Rio	R
Merrill Necta-Heath	R
Merrill Pageant	R
Merrill Rodeo	R
Merrill Schooldays	R
Merrill Splendor	R
Merrill Yellow King	R
Merritt	R
Merritt Gold	R
Meteor	R
Miller's Late	R
Missouri	R
Modoc	E
Muir	R
Nectacrest	R
Nectalate	R
Nectar	R
Nectarose	R
Nestor	G
Newday *(New Jersey 79)*	R
New Rochester	R
Noble Red	G
Norwalk	R
Okinawa	R
One Star	G
Ontario	E
Opulent	R
Orange Cling	R
Orange Cling, Placerville strain	E
Oriole	R
Oso Grande	R
Paradise	R
Paloro	E
Peak	E
Pearson Hiley	R
Pedersen	G
Peento	R
Penryn	R
Peppermint (Fl.)	G
Perigrine	G

Foliar Gland Characters in Peach and Nectarine Varieties—Continued

Variety	*Gland Type*
Peterson Elberta	R
Phillips Cling	G
Pinkerman	R
Pioneer	R
Plantz	G
Polly	G
Poppy	G
Prairie Clipper *(Illinois K47)*	R
Prairie Dawn *(Illinois K73)*	R
Prairie Daybreak *(Illinois K69)*	R
Prairie Rambler *(Illinois K43)*	R
Prairie Rose *(Illinois K80)*	R
Prairie Schooner *(Illinois K40)*	R
Prairie Sunrise *(Illinois K74)*	R
Pratt-Low	G
Prenda *(Rosy)*	R
Preuss Gem	R
Primrose	R
Prince of Wales	E
Radiance	R
Ramona	G
Rancho Redleaf	G
Rand	G
Ranger *(USDA B 12160)*	R
Ransom	R
Raritan Rose	R
Red Bird	R
Redcap	G
Redchief	R
Redelberta	R
Redglobe *(USDA B7398)*	R
Redhaven	R
Redrose	R
Redskin	R
Redwing	R
Red Muir	R
Reniform Carolyn	R
Richhaven	R
Rio Oso Gem	R
Robin	G
Rochester	R
Rosebud	R
Royal Fay	R
Royal Hale *(Anderson 1B36)*	R
Royal June *(Beauty Flame)*	R
Royal May *(Anderson 10K99)*	R
Royal Redleaf	R
Rubidoux	R
Runyon Orange Cling	G
S-37 *(Striblings S-37-18)*	G
Salberta	R
Salway	R
San Jose Pink (Fl.)	R
Saturn	R
Seashore	R
Selma	E
Shalil	R
Shamrock	R
Shanghai	R
Shannon	G
Sharon	R
Shasta	G
Shipper's Late Red	R
Sierra Cling	R
Sims	R
Slappey	R
Socala	R
Somervee *(Seedling 39011)*	G
South Haven *(Sun Glo)*	G
Southland	G
Sowell	G
Springtime	G
St. John	G
Stabler	G
Stanford	G
Stark Late Gold	R
Stark Redgold	G
Stark Sure Crop	R
Starking Delicious	R
Starn	R
Starn Free	G
Stoner	R
Strawberry Cling	E
Strawberry Free	G
Stuart *(Stuart-Gomes)*	G
Sullivan 1 *(Sullivan Adair)*	R
Sullivan 2 *(Sullivan Carol)*	T
Sullivan 4	G
Sullivan Early Elberta	R
Summercrest	R
Summerrose *(New Jersey 101)*	R
Sunbeam	R
Sunday *(Sunday Elberta)*	R
Sun Flame	G
Sunglow	R
Sungold	R
Sunhaven	G
Sunhigh	R
Sunrise *(New Jersey 133)*	R
Sunset	G
Sutter	G
Taylor	E
Tejon	E
Three Star	R
Tom Thumb *(Dwarf)*	E
Tosetti Late Free	G
Triogem	R
Triumph	G
Tudor	R
Tulip	R
Tuscan *(Tuskena)*	R
Two Star	G
Valiant	R
Valigold	R
Van Emmon	E
Vanguard	R
Vedette	R
Veefreeze	R
Ventura	R
Vesper	R
Veteran	R
Vetter Elberta	G
Viceroy	R
Vivian *(USDA W21-19C)*	G
Wahlbert	G
Weldon	R
White Hale	R
Wickersham	R
White Heath	R
Wildrose *(New Jersey 118)*	R
Williams	G
William's Gem	R
Wilma	R
Wiser *(Lovell Cling)*	G
Yellow Swan	R
Yunnan	R
Zollesi Cling	G

NECTARINES

Annabella	R
Beacon	R

Foliar Gland Characters in Peach and Nectarine Varieties—Continued

Variety	*Gland Type*
Bim	R
Boston	G
Cavalier *(V.P.I. 17)*	R
Dargaville	R
Early Flame	R
Early Le Grand	R
Early Sungrand *(Anderson 2B49)*	R
Fireglobe *(California C5-275)*	G
Flaming Gold *(Fuzzless) (Burbank's Fuzzless)*	R
Freedom *(Anderson 9K66)*	G
Garden State	R
Gladys May	R
Gold	R
Gold King	R
Gold Mine	R
Gold Nugget	G
Golden Free *(Anderson 6K32)*	R
Golden Grand *(Anderson 4K30A)*	R
Gower	E
Grandandy *(Anderson 1B41)*	G
Grand Haven *(Anderson B72E)*	R
Grandoso *(Anderson 10K6)*	R
Grand Prize *(Anderson 4K30B)*	G
Grand River	R
Grand River B3 *(Anderson B3)*	R
Grandeur *(Anderson 477)*	R
Hayes Late	G
Howard	R
John Rivers	R
Jordana	R
Kim	E
Late Le Grand	R
Le Grand	R
Liberty *(Anderson 7K62)*	G
Lippiatt *(Lippiatt's Late Orange)*	E
Lord Napier	R
Mabel *(California 27-12a) (California 27-13)*	R
Marigold	R
Merrill Casa Linda	R
Merrill Princess	R
Merrill Sunrise	R
Newton	R
New Boy	R
New White *(Large White)*	R
Palomar	R
Panamint	R
Philp *(California 27-12)*	G
Pioneer	R
Quetta	R
Red Grand	R
Red River *(Anderson 6K52W)*	R
Rose *(Anderson 6K50W)*	R
Royal Flame	R
Sequoia	G
Shirley	R
Sierra	G
Silver Lode	R
Spanish	R
Stanwick	R
Star Grand *(Anderson 6K98)*	R
Star Grand II	G
Stark Early Flame	R
Sun Flame *(Anderson 4K20)*	G
Sun Grand *(Sunbrite)*	G
Tioga	G

Use of the List

This list is intended as an aid to the identification of peach and nectarine varieties that may be encountered in California. A number of varieties reported for California are not listed because the authors were unsuccessful in learning the gland types for them. It is hoped that the nurseryman, the nursery inspector, and others will make ample use of the list and that it will contribute toward the reduction of variety mixtures resulting from mistaken identity.

Gland types are determined by macroscopic examination of young but fully developed leaves, such as may be found on an actively growing shoot. Large leaves give more reliable results than do smaller ones. Leaves malformed by disease, insects, mechanical damage or physiological factors have little value in identification work. Nursery trees are best checked during the middle of summer when the trees are making normal growth. Several leaves on different limbs should be examined to determine the gland type. In the list, reniform glands are designated by "R," globose by "G," and eglandular by "E." Reniform glands are recognized by their kidney shape and by the fact that they are sessile (Fig. 1A). Well developed reniform glands my be observed on Elberta, Gaume and J. H. Hale varieties. If any reniform glands can be distinguished on the leaves of a tree, the variety is considered to be of the reniform type. Globose glands are recognized by the fact that they are round and are short-stalked (Fig. 1B). Peach glands are deciduous, and regardless of the type, a reniform shaped scar may result; for this reason, it is important not to base determinations on old leaves. The glandless types are accompanied by leaf margins with distinct serrations (Fig. 1C). Leaves of the reniform and globose types generally have crenate margins.

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Hoja Blanca (White Leaf), a Destructive Virus Disease of Rice

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Hoja blanca, or white leaf, is a virus disease of rice. The first time it was reported in the United States was in Florida, in 1957 (6). It has since been reported in Mississippi (4, 7). It also has been reported in other countries in the western hemisphere. These are Colombia, Costa Rica, Panama, Cuba and Venezuela (6, 8, 10, 14). It is reported to have caused a 25 percent loss in the rice crop in Cuba in 1956. Some fields had their yields reduced by 50 percent in that year (2).

This virus-caused disease has symptoms very similar to those of the rice stripe virus disease in Japan (12, 15, 16, 17). That disease has caused serious damage to rice in Japan since the early 1930's (16).

California planted about 226,000 acres of rice in 1957 that produced a total income of approximately $41,697,000 in that year (3). It would appear that these are diseases for which we want to be constantly on the alert so that we can discover and eliminate any incipient infestations.

Symptoms

The symptoms associated with the hoja blanca disease in Cuba and other western hemisphere countries (6, 8) are described below. Aboveground, they are very similar to those reported for the rice stripe disease in Japan (12). (We have not seen a description of any below ground symptoms for the disease in Japan).

Symptoms associated with hoja blanca consist of longitudinal pale yellow or white stripes on the leaves (Figs. 1-upper and 1-middle). Sometimes the leaves are mottled (Fig. 1-middle). Other times they are nearly or completely white (Fig. 1-lower). Affected plants usually are stunted, but individual plants can be found that are longer than normal, and have elongated flag leaves. Infection apparently can occur any time in the life of the plant. Plants that are infected early in the season may be killed. Heads (panicles) are reduced in size and often are not fully exserted or emerged from the sheath (Fig. 1-upper), or are lacking. When produced, they may lack floral parts. If these are present, they usually are sterile. This results in heads that contain few or no seeds, and remain in an upright position (Fig. 2). The grain hulls (lemma and palea) turn brown, dry prematurely, and frequently are distorted in shape (Fig. 1-upper). The roots of affected plants may be reduced in number, and blackened. This condition quite often is followed by the abnormal production of roots at all of the underwater nodes.

Host Range

The hoja blanca disease has been reported on rice, *Oryza sativa* L., in Mississippi, Florida, Colombia, Cuba, Costa Rica, Panama and Venezuela (7, 8). Tests by U. S. Department of Agriculture plant breeders indicate that the following rice varieties are susceptible to the disease: Fortuna, Caloro, Rexora, Zenith, Magnolia, Texas Patna, Bluebonnet 50, TP 49, Century Patna 231, Nata, and Toro. The following varieties appear to be resistant: Colusa, Arkrose, Asahi, LaCrosse X Magnolia (C. I. 9001), Missouri R-500, Bruin Sel. X Zenith (C. I. 9209), La Crosse X 253, La Crosse X Zenith-Nira, and La Crosse X Arkrose (6, 8).

In Florida symptoms similar to those observed on rice plants also were observed on many native grasses (6, 11). These were: Alexander grass, *Brachiaria plantaginea* (Link) Hitchcock; jungle rice, *Echinochloa colonum* (L.) Link; barnyard grass, *E. crus-galli* (L.) Beauv; salt marsh cockspur-grass, *E. walteri* (Pursh) Heller; witchgrass, *Panicum capillare* L.; browntop panicum, *P. fasciculatum* Swartz; Gibbous panic-grass, *Sacciolepis striata* (L.) Nash; and red rice, a strain of *Oryza sativa*.

The rice stripe disease in Japan has, in addition to rice, the following host range:

Rice cutgrass, *Lerrsia orysoides* (L.) Swartz; rescue grass, *Bromus catharticus* Dahl; manna grass, *Glyceria acutiflora* Torr.; little quaking grass, *Briza minor* L.; Bermuda grass, *Cynodon dactylon* (L.) Pers.; Sudan grass, *Sorghum sudanense* (Piper) Stapf.; Johnson grass, *S. halepense* (L.) Pers.; and a species of *Trisetum*, *T. bifidum* (17).

While neither the hoja blanca nor the stripe diseases of rice have been seen in California, the following hosts, in addition to rice, are known in the State: Barnyard grass, jungle rice, rice-cut grass, rescue grass, little quaking grass, Bermuda grass, Sudan grass, and Johnson grass (13). There is no report of *T. bifidum* occurring in the United States.

Insect Vector

The known insect vectors of the hoja blanca disease of rice in the western hemisphere, and the stripe disease of rice in Japan belong to the plant hopper or lantern fly group (Fulgoroidea). In Cuba the hoja blanca virus is transmitted by the plant hopper, *Sogata orizicola* Muir (5, 8, and Fig. 3). This insect recently has been found in Florida and Mississippi in the areas where the disease was found (4, 7, 8).

In the case of the rice stripe disease in Japan, the known vector is the plant hopper, *Delphacodes striatella* Fall. (15). This insect has not been found in the hoja blanca infested rice fields in the western hemisphere (8), although, during a preliminary

FIGURE 2. (Left) Heads of noninfected rice plants showing the normal drooping of the perfectly formed heads. (Right) Heads (panicles) of hoja blanca infected rice plants showing the stunted, upright condition of the imperfectly formed heads. Photograph courtesy of Dr. John G. Atkins, Crops Research Division, ARS, USDA.

survey in Cuba, a species of *Delphacodes* was found to be present in one planting of rice. Species of *Delphacodes* normally are wild grass feeders in that country (14).

Several species of *Delphacodes* are found in California, the more common ones being: *D. consimilis* (VanD.), *D. gillettei* (VanD.), *D. pacificus* (Crawf.) and *D. propinqua* (Fieb.). The genus *Sogata* is not known to occur in California, but representatives of this genus are reported from Georgia and Texas (9), as well as from Florida and Mississippi.

The plant hoppers usually are found in grassy or weedy areas. When inspections are made for them in and near rice plantings, it would be well to sweep not only the rice itself, but the grassy margins of the field as well. Occasionally, these insects may be found on low shrubbery.

Most of the plant hoppers resemble the true leafhoppers in appearance, but differ mainly by having a flat, verticle face, and clear wings. Certain adult members of this group have a short-winged form which gives them the appearance of being immature.

Control

Possibility of damage from the hoja blanca disease in rice can be lowered, and possibly prevented, by the destruction of all infected hosts, including weeds, and by the control of all plant hopper vectors of the disease-causing virus. When the disease was discovered in Florida, an eradication project was immediately instigated. Three methods of eradication were used: (1) the infested area was sprayed with malathion to destroy possible insect vectors; (2) all infected rice fields were destroyed by deep plowing; (3)

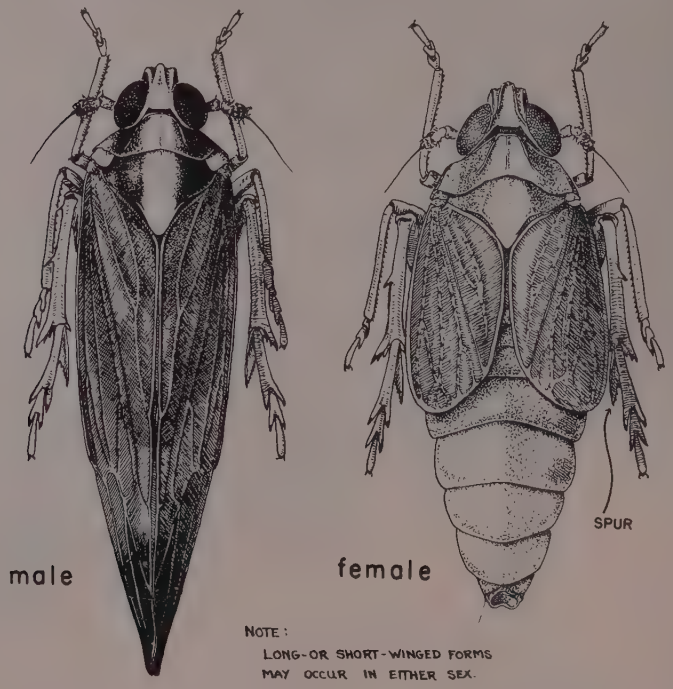
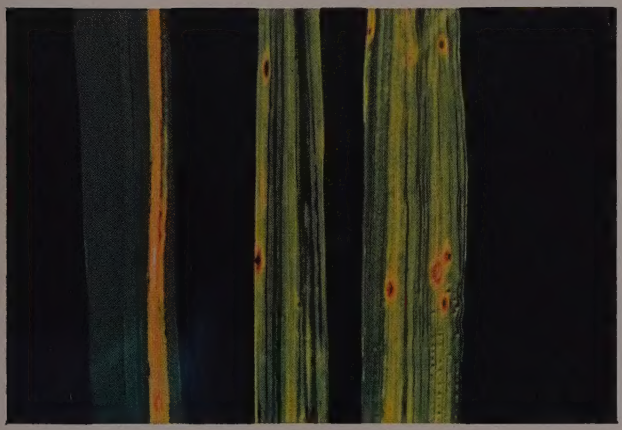


FIGURE 3. The plant hopper, *Sogata orizicola* Muir, vector of the hoja blanca virus. Illustration courtesy of Insect Identification and Parasite Introduction Laboratories, ERD, ARS, USDA (5).

Heads (panicles) and subtending sheaths from hoja blanca infected rice plants. Note misshapened kernels, incomplete emergence of the heads from the sheaths and yellow stripes on the sheaths.



Leaves from hoja blanca infected rice plants. Note yellow and mottled (yellow and green) stripes on the infected leaves.

A rice field with many plants showing the white to yellowish-white leaf symptom of the hoja blanca disease. (Brown spots on sheaths in upper and on leaves in middle are fungus-caused and are not symptoms of the hoja blanca disease.) Colored photographs courtesy of Dr. John G. Atkins, Crops Research Division, ARS., USDA.

all grasses that exhibited suspicious symptoms were killed with chemical weed killers (1, 2).

Detection Programs in California

A limited disease detection program was conducted in co-operation with county agricultural commissioners during the summer of 1958 in an effort to determine whether the hoja blanca disease of rice is present in California. Approximately 3,263 acres of rice were inspected on 139 properties in 14 California Counties (Butte, Colusa, Fresno, Glenn, Madera, Merced, Placer, Sacramento, San Joaquin, Stanislaus, Sutter, Tulare, Yolo, and Yuba). No rice plants were found with disease symptoms resembling those of the hoja blanca or the stripe diseases.

A more limited insect detection program was conducted in California's "rice bowl" area. Neither the hoja blanca vector, *Sogata orizicola*, nor the rice stripe vector, *Delphacodes striatella*, were found during this program.

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Tuolumne	E. J. Biglow (DSS)* 9 Washington St., Sonora
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Yolo	Chas. H. Hardy (S) 70 Cottonwood St., P. O. Box 175, Woodland
Yuba	Chester M. Wicker (DSS)* 14th and I Sts., P. O. Box 264, Marysville

* Deputy State Sealer
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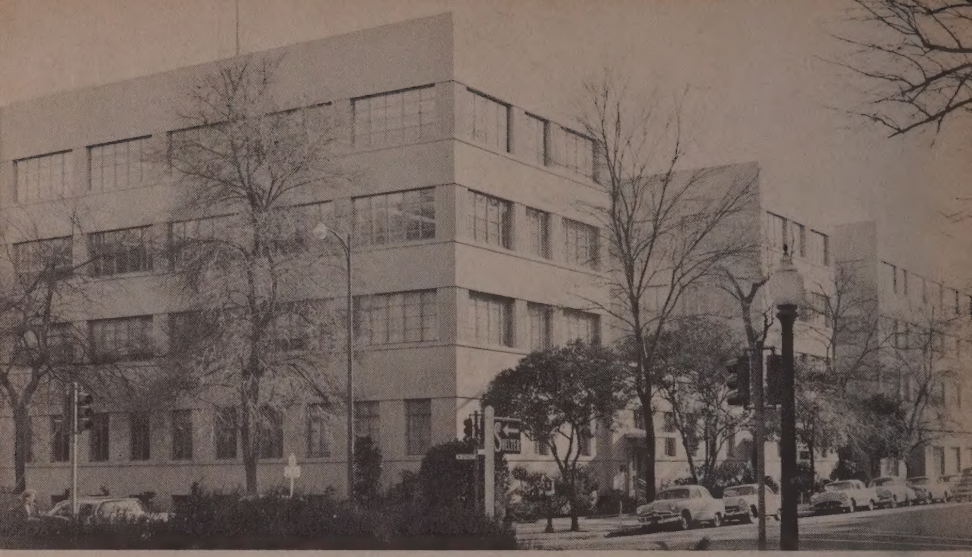

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